

---

# Project GRAD: Two-Year Outcomes of a Randomized Controlled Physical Activity Intervention Among Young Adults

Karen J. Calfas, PhD, James F. Sallis, PhD, Jeanne F. Nichols, PhD, Julie A. Sarkin, MS, Marilyn F. Johnson, BA, Susan Caparosa, MA, Sheri Thompson, PhD, Christine A. Gehrman, MA, John E. Alcaraz, PhD

---

**Introduction:** Project Graduate Ready for Activity Daily evaluated a program to promote physical activity through the transition of university graduation in a randomized controlled trial.

**Methods:** Three hundred thirty-eight university seniors participated in either a cognitive-behavioral intervention course or a knowledge-oriented general health course during the semester before graduation. Behaviorally oriented phone and mail follow-up was delivered to the intervention group for 18 months. Physical activity outcomes and mediating variables were assessed at baseline, 1 and 2 years (93% retention rate).

**Results:** There were no significant intervention effects on physical activity outcomes at 2 years for either men or women. Experiential and behavioral processes of change were significantly improved for intervention women over 2 years.

**Conclusions:** Despite excellent participation in a theoretically based, well-attended intervention, few long-term effects on physical activity or its mediators were found. Additional research is needed to determine optimal interventions for physical activity and to validate or alter current behavior change theory.

**Medical Subject Headings (MeSH):** leisure activity, adolescence, health promotion, theory, telephone counseling, early intervention (Am J Prev Med 2000;18(1):28-37) © 1999 American Journal of Preventive Medicine

---

## Introduction

Because of the well-documented health benefits of physical activity,<sup>1</sup> there is concern about the dramatic decline in physical activity over the life span,<sup>2</sup> beginning in childhood.<sup>3</sup> Epidemiologic data show a decrease in the percent of high school boys and girls who participate in 3 or more days per week of vigorous physical activity by 16% and 20%, respectively. There are further decreases during the typical university years, aged 18 to 21 (6% for men; 7% for women).<sup>1</sup> In a pilot study for the current project, almost half of recent graduates reported being less active than they were in college.<sup>4</sup> A national study of college students

found approximately 40% were inadequately active,<sup>5</sup> and these data indicate the need for interventions that target college-aged young adults.

Developmental transitions may be an important concept in understanding the age-related decline in physical activity.<sup>6-8</sup> High school and college provide many opportunities for physical activity in the form of physical education, intramural and varsity sports, and easy access to affordable exercise facilities. Upon graduation young adults have less unstructured time and reduced access to programs and facilities. This transition is characterized by concurrently increasing demands, such as beginning a career or getting married and starting a family. Therefore this and other life transitions may be periods of greater risk for relapse to a sedentary lifestyle.

The college and university settings offer many opportunities for intervening with students, through approaches that could be institutionalized, and such programs were targeted in Healthy People 2000.<sup>9,10</sup> Previous physical activity interventions in colleges were quasi-experimental,<sup>11-14</sup> so improved research designs are needed.

A recent meta-analysis shows that physical activity

---

From the Department of Psychology (Calfas, Sallis, Alcaraz), Division of Student Affairs (Calfas), Department of Exercise and Nutritional Sciences (Nichols), Graduate School of Public Health (Johnson), Project GRAD (Sarkin, Caparosa, Thompson), San Diego State University, San Diego, California.

Address correspondence and reprint requests to: Karen J. Calfas, PhD, Department of Health Promotion, Student Health Services, San Diego State University, San Diego, CA 92182-4701. E-mail: kcalfas@mail.sdsu.edu.

JA Sarkin is currently with the Department of Psychology, University of Rhode Island, Kingston, Rhode Island.

Tables of correlation coefficients and regression results are available from the first author upon request.

**Table 1.** Demographic characteristics at baseline of the original and follow-up sample

Variable	Baseline sample <i>n</i> = 338	Follow-up sample at baseline <i>n</i> = 318	Follow-up sample at 2-years, <i>n</i> = 318
% Female	54.2	54.7	—
% Euro-American	61	60	—
Mean age, SD, range	24.23 (1.95) (20–29)	24.18 (1.93) (21–29)	—
% Single	86.4	85.8	—
% Work full or part time	79.8	79.9	90
% Attending school full time	86.4	86.5	*
Living situation (%)			
Off campus w/roommates/partners	69.5	67.9	55
On campus or fraternity/sorority	5.7	5.6	0
With parents	24.9	26.4	28
Lived alone	—	—	13
Other	—	—	4
Mean Body Mass Index, SD, range	24.26 (4.00) (16.65–45.81)	24.3 (4.06) (16.65–45.81)	24.3 (4.1) (17.2–48.2)
% Classified as “inactive”	43.5	43.2	37.3

\*At 2 years 87% completed their undergraduate degree and about 11% were enrolled in graduate school.

interventions are generally effective,<sup>15</sup> but the authors cite 2 criticisms of this literature that are addressed in the present study. The first is poor maintenance of behavior change. The lack of continued intervention effects over time is not unique to interventions of physical activity.<sup>16,17</sup> Promising strategies for supporting long-term change with cost-effective approaches include mail and phone interventions<sup>15,18–20</sup> that proved more effective than face-to-face interventions in some cases,<sup>15,21</sup> possibly due to greater convenience of home-based programs. The acceptance, low cost, and evidence of efficacy of phone and mail interventions supports further evaluation of these methods for their ability to enhance long-term maintenance.

A second criticism of the literature is that most studies do not evaluate the effect of the intervention upon the theoretical mediators of behavior change that are targeted in the intervention. Additionally, most studies do not evaluate whether changes in mediators are related to changes in outcome. Baranowski and colleagues<sup>22,23</sup> recommend conducting analyses that (1) assess the impact of the intervention on the hypothesized mediating variables and (2) assess covariation between changes in mediators and outcomes. Such analyses test hypotheses derived from behavioral change theories and may lead to improvements in theories and interventions.

The purpose of Project GRAD (Graduate Ready for Activity Daily) was to evaluate a generalizable intervention to promote adoption and maintenance of physical activity among young adults transitioning from university to adult roles. The present study improves on previous research by assessing longer-term outcomes of both physical activity and theoretically derived mediators, and the relation between the two.

## Methods

### Participants

Participants were 185 male and 153 female seniors from a large urban university who responded to an invitation to participate in a health course with follow-up intervention. Demographic data on the original and follow-up samples are provided in Table 1. Eligible students were between the ages of 18 and 29, of senior class standing, and intending to graduate in the next 2 semesters. Students not able to perform moderate-intensity physical activity were excluded. The university identified students meeting the inclusion criteria, and project staff called them for screening and to extend an invitation to participate. The study sample was defined as the 338 students who completed baseline assessments and attended the first 3 classes. Students were recruited in 2 cohorts during consecutive semesters. Complete details about the recruitment procedures are published elsewhere,<sup>24</sup> and participants were generally representative of the senior population. Two-year follow-up data were collected on 314 participants, representing a 93% retention rate.

### Design and Procedures

Following baseline assessment, students were randomly assigned to receive the intervention, a course designed to promote adoption and maintenance of physical activity, or a control course covering general health topics. Both courses were offered for 2 units of upper-division course credit. Students selected a time that fit their schedules and were then randomly assigned to the control or experimental course offered at that time. Students were assessed at baseline, at the end of the course, and at the 1- and 2-year anniversary of baseline.

This study was approved by the University's Committee for the Protection of Human Subjects, and all participants provided written informed consent.

**The GRAD intervention.** The intervention was based on principles and findings from exercise and behavioral science. The physical activity goals were derived from national guidelines such as those in the Surgeon General's Report.<sup>1</sup> The behavioral science component was based on the Transtheoretical Model<sup>25</sup> and Social Cognitive Theory.<sup>26</sup> Psychosocial determinants of physical activity based on each model have been identified in the general population<sup>1,27</sup> as well as in college students.<sup>4</sup> Change in the psychosocial correlates is presumed to mediate changes in physical activity outcome.<sup>23</sup> The intervention, therefore, targeted these variables for change, including (1) self-efficacy, or one's confidence in changing a specific behavior in a given circumstance; (2) social support; (3) outcome expectations, or perceived benefits; (4) barriers to changing behavior; (5) enjoyment of the behavior; and (6) use of experiential and behavioral processes of change. The intervention took an initial level of activity ("active" vs "inactive") into account, and intervention approaches were tailored to these 2 groups. Intervention participants received a 1-semester, 2-unit course consisting of a weekly faculty-led lecture and peer-led lab before graduation and peer-based phone and mail follow-up intervention for 18 months following graduation. Formative evaluation of current students and recent alumni was used to guide the development of the intervention.<sup>4</sup>

**Pregraduation intervention.** Intervention students attended 15 weekly 50-minute lectures led by 1 behavioral and 1 exercise science faculty member. Sessions addressed the benefits and potential risks of physical activity, the current recommendations regarding the amount and type of physical activity required to improve health and fitness, and methods of behavioral self-management. Specific topics related to each of these aims were presented during the lecture (up to 75 students) and in assigned readings. Consistent with national guidelines,<sup>1,10</sup> regular moderate- or vigorous-intensity physical activity along with exercises to enhance strength and flexibility were emphasized.

Students applied what they learned during a 110-minute, weekly lab experience led by "peer health facilitators" (up to 15 students). Each lab included supervised physical activity and personal application of the behavioral management strategies, including group discussion of previously set goals and homework assignments.

Specific intervention components were designed to change physical activity outcomes and potential psychosocial mediators. For example, the importance of social support was presented in the lecture, and students made plans to request more social support in the labs.

**Table 2.** Schedule and topics of follow-up phone and mail intervention

Month of Follow-Up	Phone Call Topics
1	Goal setting and relapse intervention
2	Cost-benefit
3	Self-talk
4	Open problem solving*
5	Stress management
6	Prompt call**
7	Enjoyment
8	Lifestyle physical activity
9	Social support
10	Convenience
11	Time management
12	Open problem solving
13	Prompt call
14	Prompt call
15	Open problem solving
16	Prompt call
17	Prompt call
18	Relapse prevention

\*Open problem solving occurred when a participant identified a relevant behavioral topic for discussion.

\*\*Prompt call was a very brief call to remind participant to be active. The "GRADuate" Newsletter developed by Project GRAD, and "Fitness Matters" from the American Council on Exercise were sent in alternating months.

Additionally, the intervention emphasized transition issues in both the lecture and lab (e.g., how to continue exercising despite new job or family responsibilities). Students also wrote term papers in which they anticipated their lifestyles and barriers to physical activity 3 years after graduation and made behavioral plans to cope with these new barriers. The pregraduation intervention, course topics, and results are described further elsewhere.<sup>28</sup>

**Follow-up intervention.** The 18-month postgraduation intervention extended the initial intervention effects by assisting participants as they made the developmental transition from the university to other life roles. Phone and mail methods were selected because they were believed to be practical and generalizable through alumni associations. Participants received monthly mailed materials with follow-up phone calls from a counselor that reflected the content of the mailing. Calls and mailings were decreased in frequency toward the end of the follow-up period to allow participants to practice physical activity maintenance. Table 2 shows the schedule and topics of the follow-up intervention.

Four counselors conducted the follow-up intervention calls (3 women, 1 man), 3 of whom were peer health facilitators during the pregraduation intervention. All counselors were trained by project investigators and supervised by feedback on audiotapes or direct observation of telephone counseling. Each call lasted 5 to 10 minutes and followed a semistructured script, including sections devoted to review of a behavioral skills topic, setting a new physical activity goal, antici-

**Table 3.** Measures administered at each assessment point

Type of Measure	Reference	Subscale Scores Used in Analyses	Psychometric Properties	Method of Use
Physical activity 7-day Physical Activity Readiness (PAR) Questionnaire	Blair <sup>29</sup>	PA during leisure time: 1 Total energy expenditure relative to body weight 2 Min/wk vigorous ( $\geq 6.0$ METS) 3 Min/wk moderate (4–5.9 METS) 4 Min/wk flexibility 5 Min/wk strengthening	Substantial evidence of reliability and validity. Phone and in-person interviews are psychometrically similar. <sup>30, 31</sup>	Administered by trained staff over the phone. <sup>32</sup> Used average of 2 administrations 1 to 2 weeks apart
Stage of change for exercise	Marcus <sup>33</sup>	Proportion of “actives” (action or maintenance stage) “inactives” (precontemplation to preparations stage)	33	Used to classify participants into “active” or “less active” lab sections
Psychosocial Mediators Self-efficacy	Sallis <sup>34</sup>	“Making time” “Resisting relapse”	34	
Social-support	Sallis <sup>35</sup>	From friends From family	35	
Benefits	Sallis <sup>36</sup>	Total score	36	Perceived benefits of exercise
Barriers	Sallis <sup>36</sup>	Total score	36	Perceived barriers to exercise
Enjoyment	Kendzierski <sup>37</sup>	Average rating	37	Rate 18 aspects of PA enjoyment
Processes of change	Marcus <sup>38</sup>	“Experiential” “Behavioral”	38	Average rating of techniques people use to change their behavior

METS, metabolic equivalents; PA, physical activity.

pating upcoming risks for relapse, and problem solving around barriers. After the first 6 months of follow-up, “prompt” calls were introduced based on findings that the frequency of calls was more important than their content.<sup>19</sup> Prompt calls did not require direct communication with the participant. It was often a message left on an answering machine. The purpose of these calls was to prompt physical activity and to invite the participants to call their counselors if they wanted additional assistance.

Between calls, participants received alternating newsletters. One focused on exercise science topics (American Council on Exercise, “Fitness Matters”). The second newsletter was written by project GRAD staff (“The GRADuate”) and included a main article on a behavior change method that corresponded to the upcoming call. Additional articles reviewed fad diets and physical activity products, encouraged participants to try new physical activities, and relayed behavior change success stories. Tip sheets on specific topics (e.g., how to pick a good walking shoe, exercising in bad weather) were sent to participants upon request. The follow-up intervention was delivered to participants in 10 states and 5 foreign countries, and over 95% of all follow-up calls were completed.

**Control condition.** Students in the control condition attended 2 hours of lecture weekly for 15 weeks. The course was led by a doctoral-level instructor and covered general health topics. The emphasis of the course was on knowledge acquisition, rather than behavioral change principles. During the 18-month follow-up period, participants received the “Berkeley Wellness Newsletter” bimonthly.

## Measures

All measures are published and have adequate or better test-retest reliability. They are described in more detail in Table 3. Self-report physical activity and total energy expenditure were assessed using the 7-Day Physical Activity Recall interview (PAR) and summarized into 5 variables for analyses. Stage of change for exercise was used to classify participants as “active” (action and maintenance stages) or “inactive” (precontemplation through preparation stages) at baseline. Five mediating variables related to Social Cognitive Theory or the Transtheoretical Model were assessed at each measurement point as part of a 20-page questionnaire.



## Analysis

### Intervention effects on physical activity and mediators.

The effects of the intervention on physical activity outcomes and the 9 mediator scores were analyzed using a series of ( $2 \times 2 \times 3$ ) repeated measures ANCOVA. Two between-subjects factors included condition (intervention/control) and activity status at baseline (active/inactive). The within-subjects factor was time (preintervention, 1-year, and 2-year follow-up assessments). Season at baseline, categorized as Fall or not Fall, was the covariate. Because the 2 cohorts were assessed at different times of year, the “season” variable adjusted for both cohort and season. All analyses were conducted separately for men and women. Only 2- or 3-way interaction effects involving time and condition were reported and interpreted. To quantify the magnitude of the observed effects, proportion of variance accounted for was reported, based on partial eta-squared.

**Change in mediators predicting change in physical activity.** Regression analyses were performed to determine which mediators were significantly associated with change in physical activity. Before these analyses, residualized change scores adjusting for baseline were calculated for all mediators and physical activity measures. The physical activity change scores were then correlated with the baseline mediators, the mediator change scores, and 3 demographic variables (marital status, age, and ethnicity). Those variables that were significantly correlated with a physical activity change score ( $p < 0.10$ ) were selected for inclusion in the regression model predicting that physical activity change score. To adjust for any differences in physical activity change that might exist among the conditions (intervention/control) and baseline activity levels (active/inactive), every regression model also included condition, baseline activity level, and their interaction. All calculations and analyses were conducted separately for men and women.

Bonferroni adjustment ( $p = 0.05/2$ ) was used to compare intervention and control groups at 1 year, and the second test compared groups at 2 years. If a repeated measures analysis of variance showed a significant condition by time interaction, we performed the 2 post hocs to determine when the difference occurred.

## Results

### Intervention Effects on Physical Activity Outcomes

Results at the end of the course have been reported,<sup>28,39</sup> so the present analyses investigate effects at 1- and 2-years after baseline. There were no significant 3-way interaction effects (condition  $\times$  activity status at baseline  $\times$  time) for physical activity outcomes among

women or men. There were also no 2-way interactions of condition by time for any of the 5 physical activity outcomes for men.

Among women, there were significant 2-way interactions of treatment condition by time for strengthening activities at one year ( $F_{3,157} = 9.97, p < 0.001$ ). Post hoc ANCOVAs controlling for baseline activity and season of measurement revealed that intervention women did more strength activities at 1-year compared to control women. This difference was not significant at 2 years. There were no significant intervention effects on total energy expenditure, hours of vigorous physical activity, or hours of moderate physical activity among women. Thus, at the 2-year follow-up there were no significant group differences on physical activity for either men or women (Table 4).

### Intervention Effects on Mediators over 2 Years

**Mediator results for women.** There were no significant 3-way interaction effects. However, women in the intervention group increased their use of experiential processes of change more over the course of the study compared with women in the control group ( $F_{3,142} = 3.74, p < 0.02$ ). In post hoc ANCOVAs controlling for baseline activity and season of measurement, this difference was maintained at the 1- and 2-year follow-ups. Similarly, women in the intervention group increased their use of behavioral processes of change compared with control participants over the course of the study ( $F_{3,142} = 7.92, p < 0.001$ ), and this difference was also maintained at the 1- and 2-year assessment. Treatment effects on enjoyment, social support, self-efficacy, benefits, and barriers were not significant, but changes were generally in the expected direction.

**Mediator results for men.** Similar to the physical activity outcomes, the intervention demonstrated almost no effect on mediator variables among men. There were significant treatment condition by time effects for men on self-efficacy (resisting relapse) and barriers, but the difference between control and intervention was not significant at the 1- or 2-year follow-up. Please see Table 5 for means and standard deviations of mediator variables.

**Utility of mediators to predict physical activity outcomes.** The regression analyses were not conducted as planned. The lack of variability in physical activity outcomes (DV) and mediators (IVs) made it impossible to predict change. Results from these analyses are not reported.

## Discussion

Two general conclusions from the present study are discussed. First, the intervention was not effective in promoting long-term physical activity. Second, the in-

**Table 4.** Physical activity over 2 years for women and men, mean (SD)

Variable/group	Baseline	One year	Two years	Effect size*
<b>Women</b>				
Total energy expenditure (kcal <sup>-1</sup> · kg <sup>-1</sup> · wk <sup>-1</sup> )				.001
Intervention	256.9 (24.2)	257.1 (28.3)	253.6 (27.4)	
Control	253.7 (22.6)	253.4 (28.5)	250.3 (23.9)	
Vigorous PA (hrs/wk)				.012
Intervention	2.15 (2.30)	2.27 (2.36)	2.36 (2.20)	
Control	1.89 (1.84)	2.12 (2.07)	1.91 (2.05)	
Moderate PA (hrs/wk)				.008
Intervention	2.98 (2.32)	2.91 (3.36)	2.10 (1.86)	
Control	2.88 (2.14)	2.39 (3.17)	2.00 (2.20)	
Strength (min/wk)				.160**
Intervention	27.2 (46.7)	41.4 (52.4)	31.4 (43.9)	
Control	28.5 (47.5)	18.2 (30.7)	21.5 (27.8)	
Flexibility (min/wk)				.068
Intervention	18.4 (30.6)	34.6 (42.0)	25.5 (31.0)	
Control	17.1 (23.8)	23.3 (27.0)	23.8 (25.7)	
<b>Men</b>				
Total energy expenditure (kcal <sup>-1</sup> · kg <sup>-1</sup> · wk <sup>-1</sup> )				.017
Intervention	262.8 (31.4)	262.6 (30.4)	257.2 (27.9)	
Control	258.7 (23.8)	257.9 (27.1)	258.3 (32.9)	
Vigorous PA (hrs/wk)				.011
Intervention	2.63 (2.44)	2.90 (3.45)	2.47 (2.65)	
Control	2.57 (2.47)	2.06 (2.14)	2.33 (3.09)	
Moderate PA (hrs/wk)				.011
Intervention	2.51 (2.20)	2.18 (2.64)	1.87 (2.14)	
Control	2.67 (2.56)	2.23 (2.37)	1.85 (1.79)	
Strength (min/wk)				.018
Intervention	51.1 (83.7)	64.0 (79.3)	65.1 (88.9)	
Control	90.7 (124.1)	77.6 (108.2)	87.0 (101.5)	
Flexibility (min/wk)				.026
Intervention	20.7 (28.3)	26.6 (28.8)	28.8 (32.3)	
Control	22.4 (29.7)	24.0 (31.0)	21.5 (24.3)	

\*Partial eta-squared of treatment condition by time effect, from repeated measures ANCOVA.

\*\*Significant post hoc at one year (treatment vs control) based on ANCOVAs. Bonferroni adjustment was used for post hoc at one and two years, alpha = 0.5/2 = .025. PA, physical activity

intervention was more successful among women than among men.

Two years after baseline, there were no significant differences between intervention and control participants on any of the 5 physical activity outcomes. The rationale for the extended intervention was that reductions in physical activity were expected unless students were assisted in using the behavior change skills learned during the initial intervention class. Given the strong theoretical basis of the extended intervention, extremely high levels of telephone-call completion, and quality control efforts, these negative findings are surprising. It is possible that limitations of the 7-Day Physical Activity Recall interview contributed to the nonsignificant results. Potential limitations include all of the problems associated with self-report, difficulty assessing moderate-intensity physical activity, and lack of validity data to support our modifications to the interview to include strengthening and flexibility physical activity. However, the 7-Day PAR showed significant

differences at posttest,<sup>28</sup> and estimates were improved by collecting two 7-day recalls at each follow-up measurement.

Sarkin and colleagues<sup>24</sup> demonstrates that the sample was comparable to the population from which it was drawn on demographic variables. However, they may have differed on physical activity level. A self-selection bias, where active students and those more “ready” to become active may have been more likely to volunteer for the study, may account for the unexpected increase in physical activity scores for the control group from post to 1 year.<sup>28</sup> A more likely explanation of the nonsignificant findings is that the extended intervention was not sufficiently intensive. In support of this, there were some significant intervention effects at the 1-year measurement, when participants were contacted every month. After that, phone contacts became less frequent and no intervention effects were seen at 2 years. This pattern of findings suggests that frequent contact needs to be continued for as long as possible.

**Table 5.** Mediators of physical activity over 2 years for women and men, mean (SD)

Variable/group	Baseline	One year	Two years	Effect size*
<b>Women</b>				
Enjoyment				.038
Intervention	5.50 (1.03)	5.66 (0.88)	5.71 (0.81)	
Control	5.28 (1.20)	5.32 (1.07)	5.63 (1.07)	
Social support, family				.054
Intervention	20.27 (8.91)	19.11 (8.86)	21.29 (9.91)	
Control	21.27 (10.54)	20.55 (9.86)	22.26 (11.09)	
Social support, friend				.035
Intervention	27.17 (11.1)	24.80 (9.48)	24.83 (9.61)	
Control	25.45 (10.22)	24.23 (12.05)	24.43 (10.95)	
Benefits				.004
Intervention	4.48 (0.41)	4.60 (0.34)	4.63 (0.36)	
Control	4.41 (0.50)	4.49 (0.47)	4.55 (0.42)	
Barriers				.036
Intervention	1.27 (0.56)	1.17 (0.52)	1.27 (0.56)	
Control	1.25 (0.53)	1.28 (0.51)	1.25 (0.53)	
Processes of change, exp				.073**
Intervention	2.94 (0.64)	3.26 (0.67)	3.28 (0.76)	
Control	2.94 (0.77)	2.98 (0.81)	3.01 (0.74)	
Processes of Change, beh				.143**
Intervention	2.78 (0.71)	3.04 (0.73)	3.10 (0.71)	
Control	2.74 (0.77)	2.78 (0.81)	2.85 (0.79)	
Self-efficacy, make time				.041
Intervention	3.55 (0.63)	3.59 (0.70)	3.58 (0.77)	
Control	3.63 (0.79)	3.51 (0.86)	3.59 (0.66)	
Self-efficacy, resist relapse				.049
Intervention	3.71 (0.86)	3.39 (0.84)	3.31 (0.70)	
Control	3.23 (0.82)	3.18 (0.99)	3.27 (0.89)	
<b>Men</b>				
Enjoyment				.042
Intervention	5.66 (0.85)	5.64 (0.85)	5.69 (0.73)	
Control	5.86 (0.87)	5.55 (1.30)	5.84 (0.95)	
Social support, family				.068
Intervention	17.78 (6.94)	17.68 (8.89)	19.23 (10.39)	
Control	16.74 (6.82)	16.19 (6.66)	15.48 (7.54)	
Social support, friend				.023
Intervention	26.77 (9.78)	23.46 (9.26)	25.09 (8.69)	
Control	29.17 (9.41)	23.80 (9.06)	26.81 (9.81)	
Benefits				.010
Intervention	4.38 (0.43)	4.37 (0.43)	4.43 (0.40)	
Control	4.38 (0.40)	4.37 (0.43)	4.36 (0.45)	
Barriers				.152
Intervention	0.92 (0.43)	1.06 (0.49)	1.04 (0.46)	
Control	0.94 (0.51)	0.95 (0.51)	1.00 (0.48)	
Processes of change, cog				.023
Intervention	2.67 (0.73)	2.68 (0.63)	2.97 (0.67)	
Control	2.68 (0.66)	2.65 (0.71)	2.80 (0.76)	
Processes of Change, beh				.065
Intervention	2.50 (0.63)	2.76 (0.59)	2.93 (0.70)	
Control	2.71 (0.65)	2.56 (0.60)	2.71 (0.67)	
Self-efficacy, make time				.015
Intervention	3.88 (0.63)	3.68 (0.66)	3.76 (0.76)	
Control	3.90 (0.71)	3.81 (0.83)	3.80 (0.75)	
Self-efficacy, resist relapse				.093
Intervention	3.46 (0.75)	3.52 (0.82)	3.42 (0.79)	
Control	3.50 (0.83)	3.40 (0.86)	3.58 (0.81)	

\*Partial eta-squared of treatment condition by time effect, from repeated measures ANCOVA.

\*\*Significant post hoc at one and two years (treatment vs control) based on ANCOVAs. Bonferroni adjustment was used for post hoc at one and two years,  $\alpha = 0.5/2 = .025$ .

Exp, Experiential; beh, Behavioral.

The limited intervention effects on hypothesized mediators help explain the poor effects on physical activity outcomes. The intervention was specifically designed to alter the mediators that were measured. The only mediator variables that were affected long term were behavioral and experiential processes of change for women. These effects raised expectations for long-term physical activity outcomes, but perhaps the effects on processes of change were not strong enough to lead to behavior changes. No mediators were significantly altered among men, which is consistent with their physical activity outcomes.

In understanding the negative results, it is useful to note trends in the intervention and control groups. Although there were variations across outcomes, physical activity levels of intervention participants typically increased during the class, then gradually regressed to baseline levels at 2 years. Control participants generally declined during the class, then gradually increased until they were near or above baseline levels. The intervention-group pattern is commonly seen in behavior change studies, but the control pattern was unexpected. Based on epidemiologic data<sup>1</sup> and studies of university alumni,<sup>4</sup> continuous declines in physical activity were anticipated in the control participants. It is unlikely that the control class or the newsletters on general health issues stimulated a long-term increase in physical activity. However, the increase in physical activity among the control group during the follow-up period made intervention effects difficult or impossible to detect.

Although analyses examined possible differential effects on initially active and initially inactive participants, no differential effects were found (i.e., 3-way interactions). Thus, it can be concluded that the intervention did not have long-term effects on either group. The initial and extended interventions attempted to tailor specific program components to participants in different stages of change, but the results indicate that the intervention was insufficiently effective in facilitating maintenance of change in either baseline-defined subgroup. Future studies should examine whether people at varying stages of change are benefiting.

The second general finding was that the results were somewhat different for females and males. The intervention produced long-term changes in behavioral and experiential processes of change for women, and effects on some physical activity outcomes persisted at the 1-year assessment. For men, there were no long-term effects on any hypothesized mediators, nor were there any short- or long-term effects on physical activity outcomes, so further research is needed to determine how to make interventions more effective with men. The gender-specific analyses supported findings with children that physical activity interventions were more successful with females,<sup>40</sup> but the reasons for the gender differences were not clear. Because males were

more active on most physical activity outcomes than females at baseline, and were also higher on most of the hypothesized mediators (data not shown), males had less room for improvement. Their higher activity levels may have made the men feel the intervention was not relevant to them, even though they were encouraged to adopt a comprehensive physical activity program. Anecdotally, many intervention men requested to participate in more competitive sports during the lab and asked their follow-up counselors to be more like a coach and "force" them to exercise, thus indicating that the intervention was not meeting their needs. Additional qualitative research may be useful to identify gender-related preferences for intervention strategies that could improve outcomes.

Women's improvement in total physical activity at posttest<sup>25</sup> was not maintained during the follow-up period. There were no intervention effects at any time on vigorous- or moderate-intensity physical activity, which is disappointing, because these were emphasized in the interventions. However, strength and flexibility exercises showed intervention effects at posttest, and these were maintained at the 1-year assessment. This result is interesting because physical activity interventions rarely target strength and flexibility exercises. The GRAD intervention taught the benefits of these activities and convenient ways to incorporate these exercises into daily routines. The relative novelty of these exercises, compared to aerobic activities, may account in part for the effects on these behaviors. However, even these differences were not maintained at the 2-year measurement point.

The third major finding from the GRAD study was that hypothesized mediators explained little of the variance in physical activity change. Baranowski and colleagues<sup>22,23</sup> contend it is important to evaluate the ability of mediators to explain changes in behavior, yet such analyses are rarely reported in the physical activity literature. Increases in vigorous-intensity physical activity was related to an increase in enjoyment for women and a decrease in barriers for men. However, only small percentages of variance were explained. The largely nonsignificant intervention effects on the mediators probably account for these results.

The GRAD study demonstrates several methodological improvements over most physical activity interventions. Randomized design, strong theoretical basis for the intervention, high participation in extended intervention, measures of long-term outcomes, validated outcome measures, and excellent cohort maintenance are key strengths of the study. The careful assessment of mediators, linked theoretically to the intervention procedures, may be one of the most innovative aspects of the present study. It is important to evaluate the construct validity of the interventions and to continue to test hypotheses derived from theory. Intervention theories were not strongly supported. Analyses in the



present study focused on explaining behavior change during the extended intervention. For both women and men, hypothesized mediators did not explain significant amounts of variance for most of the physical activity outcomes. The two mediators significantly influenced by the intervention for women were not related to physical activity changes. In other physical activity intervention studies, major theoretically derived correlates of physical activity were largely unimproved by a behavioral intervention and accounted for very little variance in physical activity change.<sup>41,42</sup>

These results raise questions about the strength of the interventions, the measurement of the hypothesized mediators, and the utility of the underlying theories. Such questions can only be answered by continuing to study the relation of mediators to behavior change, and investigators working in all areas of behavior change are encouraged to include analyses of hypothesized mediators in their studies.

The gender-specific analyses in the present study were essential to understanding the results, but too few studies of behavior change programs report findings for important subgroups. Present results suggest that different intervention approaches may be needed for males and females, but further research is needed to identify how to optimize interventions for both genders.

Several challenges for future research were raised by the present study. The primary challenge is the continuing need to develop practical and effective approaches for long-term health behavior change. Although mediated interventions, including mail and telephone contact, have been effective in other physical activity studies,<sup>12</sup> they were not effective here. Other options for extended interventions need to be tested, including more frequent contact, different content of the interventions, and use of other media such as the Internet. If studies continue to show that interventions produce only small and inconsistent changes in hypothesized mediators,<sup>20</sup> then the structure and content of health behavior change interventions need to be reexamined. If studies continue to show little support for the ability of hypothesized mediators to explain behavior changes,<sup>20</sup> then behavior change theories need to be reexamined.

---

The authors wish to express their appreciation to Simon Marshall, LaShanda Jones, Jennifer Torio-Hurley, and Kecia Carrasco for their important contributions to the project.

---

## References

1. US Dept of Health and Human Services. Physical activity and health: A report of the surgeon general. Atlanta, GA: US Dept of Health and Human Services, Centers for Disease Control and Prevention, Public Health Service, 1996.
2. Stephens T, Jacobs JR, White CC. A descriptive epidemiology of leisure-time physical activity. *Public Health Rep* 1985;100:147-58.
3. Sallis JF. Epidemiology of physical activity and fitness in children and adolescents. *Crit Rev Food Sci Nutr* 1993;33:403-8.
4. Calfas KJ, Sallis JF, Lovato CY, Campbell J. Physical activity and its determinants before and after college graduation. *Medicine, Exercise, Nutrition & Health* 1994;3:323-34.
5. Douglas KA, Collins JL, Warren C, et al. Results from the 1995 national college health risk behavior survey. *Am J College Health* 1995;46:55-66.
6. Baranowski T, Cullen KW, Basen-Engquist K, et al. Transitions out of high school: time of increased cancer risk? *Prev Med* 1997;26:694-703.
7. Cullen K, Koehly LM, Anderson C, et al. Gender differences in chronic disease risk behaviors through the transition out of high school. *Am J Prev Med* 1999;17:1-7.
8. Baranowski T, Koehly C, Cullen K, et al. Ethnic differences in cancer risk behaviors through the transition out of high school. *Ethn Dis* 1999;9:94-103.
9. King AC, Blair SN, Bild DE, et al. Determinants of physical activity and interventions in adults. *Med Sci Sports Exerc* 1992;24:S221-36.
10. US Dept of Health and Human Services. Healthy people 2000: National health promotion and disease prevention objectives. Washington DC: US Dept of Health and Human Services, Public Health Service, 1991.
11. Adams TM, Brynteson P. A comparison of attitudes and exercise behaviors of alumni from universities with varying degrees of physical education activity programs. *Res Q Exerc Sport* 1992;63:148-52.
12. Brynteson P, Adams TM. The effects of conceptually based physical education programs on attitudes and exercise habits of college alumni after 2 to 11 years of follow-up. *R Q Exerc Sport* 1993;64:208-12.
13. Corbin CB, Laurie D. Exercise for a lifetime: an educational effort. *Physician and Sports Medicine* 1978;23:163-4.
14. Slava S, Laurie DR, Corbin CB. Long-term effects of a conceptual physical education program. *R Q Exerc Sport* 1984;55:161-8.
15. Dishman RK, Buckworth J. Increasing physical activity: A quantitative synthesis. *Med Sci Sports Exerc* 1996;28:706-19.
16. Brownell KD, Wadden TA. Etiology and treatment of obesity: toward understanding a serious, prevalent, and refractory disorder. *J Consult Clin Psychol* 1992;60:505-17.
17. Brownell KD, Marlatt GA, Lichtenstein E, Wilson GT. Understanding and preventing relapse. *Am Psychol* 1986;41:765-82.
18. King AC, Frederiksen LW. Low-cost strategies for increasing exercise behavior: relapse preparation training and social support. *Behav Modif* 1984;8:3-21.
19. Lombard DN, Lombard TN, Winett RA. Walking to meet health guidelines: the effect of prompting frequency and prompt structure. *Health Psychol* 1995;14:164-70.
20. Marcus BH, Owen N, Forsyth LH, Cavill NA, Fridinger F. Physical activity interventions using mass media, print media, and information technology. *Am J Prev Med* 1998;15:362-78.
21. King AC, Haskell WL, Taylor CB, Kraemer HC, DeBusk RF. Group- vs. home-based exercise training in healthy older men and women: a community-based clinical trial. *JAMA* 1991;266:1535-42.
22. Baranowski T, Lin LS, Wetter DW, Resnicow K, Hearn MD. Theory as mediating variables: why aren't community interventions working as desired? *Ann Epidemiol* 1997;7:S89-S95.
23. Baranowski T, Anderson C, Carmack C. Mediating variable framework in physical activity interventions: how are we doing? How might we do better? *Am J Prev Med* 1998;15:266-97.
24. Sarkin JA, Marshall SJ, Larson KA, Sallis JF, Calfas KJ. A comparison of recruitment methods to a health promotion program for university seniors. *Prev Med* 1998;27:562-71.
25. Prochaska JO, Marcus BH. The transtheoretical model: applications to exercise. In: Dishman RK, ed. *Advances in exercise adherence*. Champaign, IL: Human Kinetics, 1994: 161-80.
26. Bandura A. *Social foundations of thought and action*. Englewood Cliffs, NJ: Prentice-Hall, 1986.
27. Dishman RK, Sallis JF. Determinants and interventions for physical activity and exercise. In: Bouchard C, Shephard RJ, Stevens T, eds., *Physical activity, fitness and health: international proceedings and consensus statement*. Champaign, IL: Human Kinetics, 1994: 214-38.
28. Sallis JF, Calfas KJ, Nichols JF, Sarkin JA, Johnson MF, Caparosa S, et al. Evaluation of a university course to promote physical activity: project GRAD. *R Q Exerc Sport* 1998;70:1-10.
29. Blair SN. How to assess exercise habits and physical fitness. In: Matarazzo JD, Herd JA, Miller NE, Weiss SSM, eds. *Behavioral health: a handbook of health enhancement and disease prevention*. New York: Wiley, 1984: 424-47.

30. Montoye HJ, Kemper HCG, Saris WHM, Washburn RA. Measuring physical activity and energy expenditure. Champaign, IL: Human Kinetics, 1996.
31. Hayden HA, Sallis JF, Armstrong C, Whalen K, Sarkin J. Evaluation of the phone version of the seven day physical activity recall. *Med Sci Sports Exerc* 1998;30:S14.
32. Sarkin JA, Campbell J, Gross L, et al. Project GRAD seven-day physical activity recall interviewer's manual. *Med Sci Sports Exerc* 1997;29:S92-103.
33. Marcus BH, Rakowski W, Rossi JS. Assessing motivational readiness and decision making for exercise. *Health Psychol* 1992;11:257-61.
34. Sallis JF, Pinski RB, Grossman RM, Patterson TL, Nader PR. The development of self-efficacy scales for health-related diet and exercise behaviors. *Health Educ Res* 1998;3:283-92.
35. Sallis JF, Grossman RM, Pinski RB, Patterson TL, Nader PR. The development of scales to measure social support for diet and exercise behaviors. *Prev Med* 1987;16:825-36.
36. Sallis JF, Hovell MF, Hofstetter CR, et al. A multivariate study of exercise determinants in a community sample. *Prev Med* 1989;18:20-34.
37. Kendzierski D, Decarlo KJ. Physical activity enjoyment scale: two validation studies. *J Sport Exerc Psychol* 1991;13:50-64.
38. Marcus BH, Rossi JS, Selby VC, Niaura RS, Abrams DB. The stages and processes of exercise adoption and maintenance in a worksite sample. *Health Psychol* 1992;11:386-95.
39. Sallis JF, Calfas KJ, Alcaraz JE, Gerhman C, Johnson MF. Potential mediators of change in a physical activity promotion course for University Students: Project GRAD. (In press.)
40. Stone EJ, Baranowski T, Sallis JF, Cutler JA. Synthesis of behavioral research for cardiopulmonary health: Emphasis on youth, gender, and ethnicity. *J Health Education* 1995;26:S9-S17.
41. Calfas KJ, Sallis JF, Oldenburg B, French M. Mediators of change in physical activity following an intervention in primary care: PACE. *Prev Med* 1997;26:297-304.
42. Castro CM, Sallis JF, Hickmann SA, Lee RE, Chen AH. A prospective study of psychosocial correlates of physical activity for ethnic minority women. *Health Psychol*, in press.